NUCLEAR ENERGY RESEARCH INITIATIVE

Separation of Nuclear Fuel Surrogates from Silicon Carbide Inert Matrix

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Collaborators: None

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Project Description

Silicon carbide has become one of the prime candidates for inert matrix nuclear fuel materials for burning plutonium or for transmutation of long-lived actinides. Studies carried out by the University of Florida have shown that this material holds excellent neutronic and thermal performance capabilities. A silicon carbide matrix fuel (IMF) may run with a centerline temperature that is a few hundred degrees above the coolant temperature. Research supported worldwide has focused on silicon carbide as a suitable matrix for reprocessing spent fuel. However, techniques for processing and separating transuranic species and unspent fuel from a silicon carbide matrix have not been expertly identified.

This research seeks to fill this gap in knowledge by investigating novel techniques for separating surrogate materials from silicon carbide. Ceria will be primarily used as a surrogate material for plutonium oxide. This work will establish a protocol for dissolution of silicon carbide from ceria using technologies compatible with traditional fuel handling. Samples will be processed using melt infiltration methods that will co-dissolve processed samples with metal silicides. These melt processing techniques will be studied for ways of separating the matrix from urania and ceria. Ceria and other surrogate materials will be separated in a fashion comparable to methods reported in the literature. The resultant samples will be characterized for ease of separation, degree of safety (with regards to chemicals used and reaction products produced), and cost.

Workscope

The following primary tasks will be performed for this project:

- Examine literature for other published silicon carbide/metal melts and carry out thermodynamic screening of possible candidates
- Construct or purchase metal melt refining process equipment
- Prepare three ceria/silicon carbide ratio compositions by hot pressing
- Select four of the “best” metal refining systems and mix with the selected and milled SiC/CeO2
- Melt and add salts that are expected to cause insoluble cerium precipitates
- Identify phases by XRD and TEM and determine feasibility of this type of processing